

## **PRELIMINARY RESEARCH PROPOSAL (FY07)**

**TITLE:** Evaluate the Benefits of Transporting Juvenile Salmonids From Lower Monumental Dam

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**DURATION OF PROJECT:** 2007 to 2009

**DATE OF SUBMISSION:** July 2006

### **PROJECT SUMMARY**

The goal of this project is to provide statistically valid comparisons of the smolt-to-adult return rates (SAR) of Snake River juvenile salmonids that migrate in-river compared to those transported from Lower Monumental Dam around the remaining 4 dams of the Federal Columbia River Power System (FCRPS). Yearling Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) (wild and hatchery combined) will be PIT-tagged at Lower Monumental Dam and either loaded on a barge for transport or returned to the river to migrate. Based on SARs to Ice Harbor Dam, we will calculate a 95% confidence interval (CI) for the overall transport/in-river-adult-return-ratio (T/I). Adult returns from 2007 marking will

continue through 2010. The study should be repeated in 2008 and 2009 to account for inter-annual variability in results due to changing freshwater and ocean conditions.

The study will be conducted using state-of-the-art facilities and technologies and under environmental conditions known to provide as favorable in-river passage conditions as possible through the FCRPS as it is currently configured and operated.

### **Relevance**

This study addresses needs identified in NOAA's 2004 Biological Opinion (BiOp) "*The Action Agencies will continue to conduct RM&E to provide information on juvenile fish transportation and delayed mortality*", and the 2005-2007 Implementation Plan for the Federal Columbia River Power System Endangered Species Act Updated Proposed Action of the U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration (dated May 2005). Specifically, the Implementation Plan, under the Hydropower Action Effectiveness Research section (page 40), they state "*Advance the understanding of the effectiveness of flow augmentation, spill, **transportation**, and system configuration changes on fish survival for each ESU*".

This study also addresses RPAs identified in NOAA's 2000 BiOp including *Action 48* addressing the effects of prior transport as smolts on the homing of adults, *Action 49* addressing the effects of the timing of transport release so that fish arrive at the estuary at the optimum time, and *Action 185* aimed at defining juvenile migrant survival for both transported and nontransported migrants including a comparison of SARs of both groups to estimate *D*.

## BACKGROUND

Research to evaluate the effects of transporting juvenile salmonids around dams began over 30 years ago and continues today (Ebel et al. 1973, Slatick et al. 1975, Ebel 1980, Park 1985, Williams et al. 2005). From these studies, the apparent benefits of transportation have been found to vary by species and location (Ward et al. 1997, Williams et al. 2005). However, information to determine the efficacy of transporting smolts from Lower Monumental Dam is very limited (Berggren et al. 2005, Williams et al. 2005). For example, from studies conducted by NOAA Fisheries in 1995 through 2000 (excluding 1997), from yearling Chinook salmon PIT-tagged and released at Lower Granite Dam and later collected and transported from Lower Monumental Dam, a total of only 12 wild and 18 hatchery transported adults returned, with no adults returning in several study years (Williams et al. 2005). Significantly fewer adult wild and hatchery yearling Chinook salmon transported from Lower Monumental Dam as juveniles than those migrating in-river returned from fish tagged in 1999, with no significant differences found in other years, primarily due to small sample sizes. For steelhead, 93 wild and 11 hatchery transported steelhead have returned (1998- 2000 NOAA Fisheries studies), with a significantly higher SAR for Lower Monumental Dam transported wild fish found than for those migrating in-river in 2000.

From studies where PIT-tagged smolts were released above Lower Granite Dam, then collected and transported from Lower Monumental Dam, a total of 11 wild and 127 hatchery yearling Chinook salmon adults have returned from 1994 through 2003 study years (Berggren 2005). For steelhead PIT tagged above Lower Granite Dam and transported from Lower Monumental Dam, only 8 wild and 2 hatchery adults have returned for study years 1997-2002.

Based on hatchery yearling Chinook salmon PIT-tagged above Lower Granite Dam or wild yearling Chinook salmon tagged at Lower Granite Dam, and either transported from Lower Granite Dam or returned to the river, the efficacy of transportation has been shown to vary widely within a season as well as from year to year (Muir et al. *In press*). Similar findings were reported by Williams et al. (2005). However, temporal data on SARs of smolts transported from Lower Monumental Dam does not currently exist.

## **APPROACH**

### **Objective 1**

**PIT-tag groups of wild and hatchery yearling Chinook salmon and steelhead smolts at Lower Monumental Dam to evaluate transportation.**

In 2007, we propose to PIT tag wild and hatchery Snake River yearling Chinook salmon and steelhead to provide a statistically valid comparison of the SARs between between marked smolts transported from Lower Monumental Dam to below Bonneville Dam and those allowed to migrate in-river from the tailrace of Lower Monumental Dam. If possible, we will also estimate SARs for both groups on a temporal (e.g. weekly) basis, dependent on availability of fish. For both yearling Chinook salmon and steelhead, PIT-tagged fish will represent the composite population of fish collected and transported from Lower Monumental Dam. This will provide statistically-bound point estimates of transport and in-river SARs and a T/I for each species, both a seasonal average as well as multiple estimates within the season.

Task 1.1:

PIT tag wild and hatchery yearling Chinook salmon and steelhead smolts in spring 2007 to establish transport and in-river groups at Lower Monumental Dam.

We recommend testing a minimum 1.3 T/I for yearling Chinook salmon and steelhead transported from Lower Monumental Dam vs. those that migrate in-river from the tailrace of the dam through 4 additional dams and reservoirs. Based on very limited data, Lower Monumental Dam transport SARs from the 1995 through 2000 studies range from 0.16 to 0.87% while transported steelhead SARs have been higher ranging from 0.43% for hatchery steelhead in 1998 to 4.75% for wild steelhead in 2000. For sample size calculations, we will assume a SAR of 1.0% for both species of fish transported from Lower Monumental Dam in 2007.

### **Sample Size Calculation**

Sample size calculations for a transport study using transport SARs relative to in-river SARs can be based on determining precision around the estimated T/I such that the ½ width of a confidence interval on the true T/I will not contain the value 1, or the confidence interval on the true natural-log-transformed T/I, LN(T/I), will not contain 0. Therefore, for a desired  $\alpha$  and  $\beta$  and specified true T/I, the number of fish needed can be determined in the following manner.

T/I is needed such that:

$$\text{LN}(\text{T/I}) - (t_{\alpha/2} + t_{\beta}) * \text{SE}(\text{LN}(\text{T/I})) \approx 0$$

and  $\text{SE}(\text{LN}(\text{T/I})) \approx \text{SQRT}(1/n_T + 1/n_I) = \text{SQRT}(2/n)$ , where  $n_T = n_I = n$  is the number of adult returns per treatment (n for transport and in-river groups set equal for simplicity). The previous two statements imply that the sample of adults needed is:

$$n \approx 2 * (t_{\alpha/2} + t_{\beta})^2 / [\text{LN}(\text{T/I})]^2.$$

Set  $\alpha = 0.05$ ,  $\beta = 0.20$ , and an expected transport SAR of at least 1.0% for yearling Chinook salmon and steelhead. Sample sizes needed at Lower Monumental Dam are listed as follows (N denotes the number of juveniles):

Species	T/I	n	NT	NI (=NT*T/I)	NTotal
Chinook	1.3	229	22,901	29,771	52,672
Steelhead	1.3	229	22,901	29,771	52,672

Therefore, we will attempt to tag a total of 53,000 yearling Chinook salmon and 53,000 steelhead at Lower Monumental Dam in 2007.

We will sample the population collected at Lower Monumental Dam at levels that will permit marking a constant rate of fish throughout the outmigration. The percentage of the daily collection we handle will depend upon the number of fish collected. Marked study fish will be held an average of 12 hours before transport or release into the Lower Monumental Dam tailrace.

As in the past, all handling/marking will be done using preanesthesia techniques (Matthews et al. 1997). After the fish are anesthetized, they will be gravity-transferred in water to a sorting trough, and sent to one of several marking stations to receive a PIT tag. All fish will be scanned for PIT tags prior to tagging to eliminate double tagging.

Lower Monumental Dam will have a removable spillway weir (RSW) installed prior to the 2007 migration. This will likely reduce the number of smolts that pass through the juvenile collection facility, particularly steelhead and may affect our ability to tag targeted numbers of

fish each week. The proportion sampled daily for marking will be established when river operation scenarios are known. Once established, we will attempt to hold the proportion sampled constant throughout the season. Any deviations will be recorded. This will provide a total adult-return estimate for marked/transported fish that represents the number of fish collected and transported.

## **Objective 2**

**Compare SARs of PIT-tagged wild hatchery yearling Chinook salmon and steelhead smolts barged from Lower Monumental Dam to below Bonneville Dam with those released into the Lower Monumental Dam tailrace.**

In 2007 through 2009, we will PIT tag wild and hatchery yearling Chinook salmon and steelhead smolts for a 3-year study to compare the adult returns to Ice Harbor Dam between marked smolts transported from Lower Monumental Dam to below Bonneville Dam and those allowed to migrate in-river from the tailrace of Lower Monumental Dam. Adults from these juvenile marking years will return through 2012.

Task 1:

Monitor PIT tag detections of wild and hatchery adult Chinook salmon and steelhead and analyze adult return data.

Ice Harbor Dam will serve as the primary detection site for adults. Data acquired from other areas will be considered ancillary. To analyze results, statistical tests will be applied when adult returns for the study are complete. Confidence intervals for the T/I will be calculated using the ratio of SAR estimates (Burnham et al. 1987) and their associated empirical variance. The

study will also produce seasonal trends in SARs and T/Is and an overall, statistically-bound T/I estimate for both species at Lower Monumental Dam.

Task 2:

Examine PIT-tag detection histories of adults as they migrate upstream through the hydropower system.

Currently, Bonneville, McNary, Priest Rapids, Ice Harbor, and Lower Granite Dams are equipped with adult PIT-tag detection systems (Harmon et al. 2003) and detection systems are planned for installation in other dams in the future. At these dams, all PIT-tagged fish passing through the fish ladders will likely be detected. Detection systems are also in place at many hatcheries in the Columbia River Basin.

To evaluate if transportation affects the homing of returning adults, we will compare the PIT-tag detection histories of transported and non-transported adult study fish as they pass upstream through PIT-tag detection systems in the Basin.

## **FISH REQUIREMENTS FOR FY 2007**

### **Lower Monumental Dam**

We will attempt to PIT tag 53,000 yearling Chinook salmon and 53,000 steelhead over about a 4 week period at Lower Monumental Dam in 2007.

## **SCHEDULE**

<u>Activity</u>	<u>FY07</u>	<u>Outyears</u>
<b>Objective 1</b>		
Juvenile fish tagging and release	April-June	Same



**Objective 2**

Adult detection monitoring

Mar-Dec

Same

**PROJECT IMPACTS, FACILITIES, AND EQUIPMENT**

1. Coordination with operations for smolt marking will be required at Lower Monumental Dam.

**PROJECT PERSONNEL AND DUTIES**

Douglas M. Marsh--biologist and principal investigator.

Kenneth McIntyre--biological technician.

Ben P. Sanford--statistician

Steve G. Smith—statistician

**TECHNOLOGY TRANSFER**

Technology transfer will be in the form of written and oral research reports as required. A draft report will be provided to the COE by 15 November each year, with a final report provided by 15 March the following spring. In this way, complete returns for each age class of adults can be included in the final report for each study year. Results will also be published in appropriate scientific journals.

**REFERENCES**

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Williams, J. G., S. G. Smith, R. W. Zabel, W. D. Muir, M. D. Scheuerell, B. P. Sandford, D. M. Marsh, R. McNatt, and S. Achord. 2005. Effects of the federal Columbia River power system on salmon populations. NOAA Technical Memorandum, NMFS-NWFSC-63.

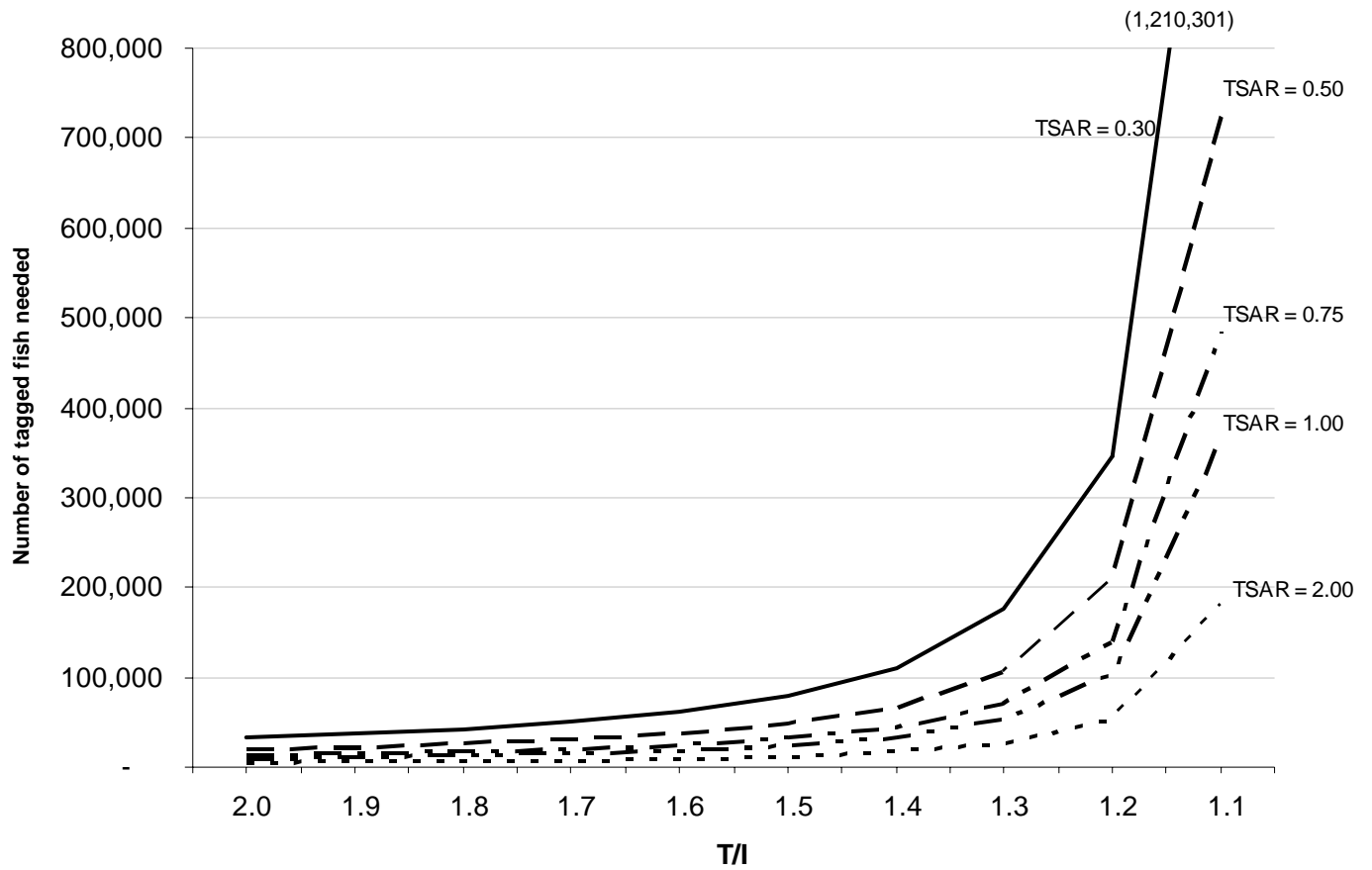


Figure 1. Number of tagged fish required for evaluation of transportation from Lower Monumental Dam under varying T/Is and transport SARs